DOCUMENT RESUME

ED 093 607 SE 017 055

TITLE	Using Gage Blocks as Measuring Standards, Aviation Quality Control (Basic): 9225.03.
INSTITUTION	Dade County Public Schools, Miami, Fla.
PUB DATE	Nov 72
NOTE	22p.; An Authorized Course of Instruction for the Quinmester Program; this is a prerequisite to SE 017 056
EDRS PRICE	MF-$0.75 HC-$1.50 PLUS POSTAGE
DESCRIPTORS	*Adult Vocational Education; Aviation Technology; Instruction; *Instructional Materials; Light; *Measurement Instruments; Science Education; *Secondary School Science; *Teaching Guides; Units of Study (Subject Fields)
IDENTIFIERS	*Quinmester Program

ABSTRACT

This unit of instruction deals with a study of the evolution and history of gage blocks and optical flats as measuring tools. Theory and principles are covered in detail. Considerable time is spent on the techniques of using gage blocks and optical flats in actual measurement set-ups. Included is the calibration and care of gage blocks and optical flats. This document will serve as a guide for high school or adult trainees. The student is expected to be proficient in, not just familiar with, the nature and the application of micrometer instruments. The booklet lists the goals, the specific block behaviors, the course outline, and a bibliography. A quinmester posttest sample with an answer key is included. (ES)

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AUTHORIZED COURSE OF INSTRUCTION FOR THE QUINMESTER PROGRAM

DADE COUNTY PUBLIC SCHOOLS

Course Outline
AVIATION QUALITY CONTROL - BASIC - 9225
(Using Gage Blocks as Measuring Standards)
Department 48 - Quin 9225.03

DIVISION OF INSTRUCTION • 1973

SE 012 055

ED 093607

D A D E C O U N T Y P U B L I C S C H O O L S

1450 NORTHEAST SECOND AVENUE

M I A M I, F L O R I D A 33132

Course Outline

AVIATION QUALITY CONTROL - BASIC - 9225
(Using Gage Blocks as Measuring Standards)

Department 48 - Quin 9225.03

county office of

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Miami, Florida 33132

November, 1972

Published by the School Board of Dade County

PREFACE

The following quinmester course outline will serve as a guide for the high school or adult trainee in the use and care of gage blocks and optical flats as precision measuring tools.

This outline consists of seven blocks of work or 135 hours of instruction which are subdivided into several units each. These blocks will involve the techniques of precision measurement with gage blocks and optical flats in the laboratory and in the shop. Procedures of instrument calibration will also be covered.

Adequate laboratory time and actual experience with serviceable parts will be provided to develop skills in the student.

The student is expected to be proficient in, not just familiar with the nature and the application of these techniques.

Prerequisite for this course is Course No. 9225.02 entitled Micrometer Instruments.

Motion picture films and color slides will be used to bring into the classroom the application of these techniques.

Study periods, group discussions, and extensive use of the textbooks and training manuals will be used. These are listed along with references and periodicals in the bibliography.

This outline was developed through the cooperative efforts of the instructional and supervisory personnel, the Quinmester Advisory Committee, and the Vocational Teacher Education Service, and has been approved by the Dade County Vocational Curriculum Committee.

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with Suggested Hourly Breakdown

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BLOCK

I. HISTORY OF GAGE BLOCKS (5 hours)

Evolution of Standards	1
The Invention of the Gage Block	1
Gage Block Nomenclature	1

II. TECHNIQUES OF USING GAGE BLOCKS (70 hours)

Combining Gage Blocks to Arrive at a Desired Diminsion	1
The Techniques of Wringing Gage Blocks	2
Procedure for Using the Gage Block Holders	2
Techniques of Using Gage Block Accessories	2
Techniques of Attribute Gaging with Gage Blocks	2
Use of Gage Blocks in the Interchange Method of Measurement by Comparison	2
Use of Gage Blocks for Direct Measurement	2
Effect of Temperature on Gage Blocks When Used in Precision Measurement	2
Work Precautions to Observe when Doing Precision Measurement with Gage Blocks	2

III. CARE OF GAGE BLOCKS (10 hours)

Keeping Gage Blocks in a Desirable Environment	3
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IV. THEORY OF LIGHT WAVES (10 hours)
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Define and Explain the Following Terms as Referred to Light 3

V. EQUIPMENT USED FOR MEASURING WITH LIGHT WAVES (5 hours)
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Light Sources Used With Optical Flats . . 4

VI. TECHNIQUES FOR MEASUREMENT WITH LIGHT WAVES (30 hours)
Positioning Part and Light Source . . . 4
Proper Selection of Optical Flat 4
Importance of Cleanliness 4
Finding the Reference Point 4
Determining Degree of Surface Flatness . . 4
Measuring Micro-Diminsions Between a Known and an Unknown Part 4

VII. CARE AND HANDLING OF OPTICAL FLATS AND RELATED EQUIPMENT (5 hours)
Cleaning and Storing Optical Flats . . . 5
Cleaning and Minor Maintenance of Light Source Equipment 5

VIII. QUINMESTER POST TEST

APPENDIX: QUINMESTER POST TEST SAMPLE 8

GOALS

The aviation quality control student must be able to:

1. Develop skills in the use of gage blocks and optical flats as precision measuring instruments.

2. Develop the attitudes of patience and persistence to gain maximum accuracy.

3. Develop the habits of cleanliness of person and work area.

4. Be aware of the responsibility involved in his chosen work.

5. Maintain the standards required for the field.

6. Control quality of the finished product.

SPECIFIC BLOCK OBJECTIVES

BLOCK I - HISTORY OF GAGE BLOCKS

The student must be able to:

1. Name and describe at least three early standards of measurement.
2. Describe in writing the lightwave as a standard, in approximately 50 words.
3. List the dimensional series used in gage block sets.
4. Explain the wringing interval.

BLOCK II - TECHNIQUES OF USING GAGE BLOCKS

The student must be able to:

1. Make up a stack of gage blocks to at least three dimensions greater than 0.1000 inch.
2. Make up the necessary stacks of gage blocks to give three dimensions less than 0.1000 inch.
3. Demonstrate proper wringing techniques for gage blocks.
4. Make a gage block set-up for attribute gaging.
5. Calibrate a high amplification comparator using gage blocks.
6. Perform one direct measurement on a part using gage blocks and wear blocks.

BLOCK III - CARE OF GAGE BLOCKS

The student must be able to:

1. Demonstrate proper cleaning procedures of gage blocks prior to wringing.
2. Completely clean and lubricate one set of gage blocks and case.

BLOCK IV - THEORY OF LIGHT WAVES

The student must be able to:

1. Write, in approximately 50 words, an explanation of wave length and frequency.
2. List the new terms he has learned about light with a brief definition.

BLOCK V - EQUIPMENT USED FOR MEASURING WITH LIGHT WAVES

The student must be able to:

1. Set up a light source for proper viewing with optical flats.
2. Identify working surfaces of optical flats.

BLOCK VI - TECHNIQUES FOR MEASUREMENT WITH LIGHT WAVES

The student must be able to:

1. Measure surface flatness on at least three different specimens.
2. Select the proper optical flat and light source angle for number one above.
3. Compare results, from number one above, with standard charts provided.
4. Measure, using optical flats, microinch difference between one known and one unknown part.

BLOCK VII - CARE AND HANDLING OF OPTICAL FLATS AND RELATED EQUIPMENT

The student must be able to:

1. Prepare a setup for measuring surface flatness on specimen provided, demonstrating proper cleaning techniques of the optical flats and work area.
2. Change a lamp on a light source fixture using proper safety precautions.

BLOCK VIII - QUINMESTER POST TEST

The student must be able to:

1. Satisfactorily complete the quinmester post test.

Course Description

9225	48	9225.03	Using Gage Blocks as Measuring Standards
State Category Number	County Dept. Number	County Course Number	Course Title

This course consists of the evolution and history of gage blocks and optical flats as measuring tools. Theory and principals are covered in detail. Considerable time is spent in the techniques of using gage blocks and optical flats in actual measurement set-ups. Included is the calibration and care of gage blocks and optical flats.

Clock hours: 135

Course Outline

AVIATION QUALITY CONTROL - BASIC - 9225
(Using Gage Blocks as Measuring Standards)

Department 48 - Quin 9225.03

I. HISTORY OF GAGE BLOCKS

A. Evolution of Standards
   1. Why a standard was needed
   2. Discuss some early standards
   3. The light wave as the modern day standard
      a. Light source and wave length used as a standard
      b. How the linear inch and meter is derived from the light wave

B. The Invention of the Gage Block
   1. Brief history of the inventor of gage blocks
   2. Gage block dimensions
   3. Temperature standards for gage blocks

C. Gage Block Nomenclature
   1. Grade classification for gage block sets
   2. Dimensional series used in gage block sets
   3. Gage block discrimination
   4. The wringing interval in gage block stacks
   5. Gage block sizes, shapes and accessories
      a. Square and rectangular gage block sets
      b. Gage block stack holders
      c. Bases, centers, scribers, and end standards for gage block stacks

II. TECHNIQUES OF USING GAGE BLOCKS

A. Combining Gage Blocks to Arrive at a Desired Dimension
   1. For a dimension greater than 0.1000 inch
   2. For a dimension less than 0.1000 inch

II. TECHNIQUES OF USING GAGE BLOCKS (Contd.)

B. The Techniques of Wringing Gage Blocks
   1. Importance of cleanliness
      a. Cleaning solvents to use
      b. Use of camel's hair trushes
      c. Lint free tissues
      d. Using the chamois
   2. Step by step procedure for wringing two gage blocks together
      a. The cleaning process
      b. Point of contact and pressure to use

C. Procedure for Using the Gage Block Holders

D. Techniques of Using Gage Block Accessories
   1. Use of end standards
   2. The purpose of, and when to use wear blocks
   3. Using the centers, scribers, base, and other related accessories

E. Techniques of Attribute Gaging with Gage Blocks

F. Use of Gage Blocks in the Interchange Method of Measurement by Comparison
   1. Use of gage blocks with dial indicators
   2. Use of gage blocks with high amplification comparators

G. Use of Gage Blocks for Direct Measurement

H. Effect of Temperature on Gage Blocks When Used in Precision Measurement
   1. The temperature standard
   2. Coefficient of expansion of various metals
   3. Techniques in reading the temperature correction slide rule
   4. Using the normalizing plate

I. Work Precautions to Observe When Doing Precision Measurement with Gage Blocks
   1. The effects of vibration
   2. Avoid drafts

II. TECHNIQUES OF USING GAGE BLOCKS (Contd.)

3. Watch for temperature changes
   a. Body heat
   b. Sunlight
   c. Direct lamplight
   d. Airconditioning
   e. Your own breath

III. CARE OF GAGE BLOCKS

A. Keeping Gage Blocks in a Desirable Environment
   1. Dust free filtered air
   2. Dehumidified atmosphere
   3. Stabilized temperature

B. Avoiding Excessive Handling

C. Handling with Insulated Tweezers

D. Laying Blocks on Their Sides on Clean Tissues

E. Keeping Box Lid Closed at All Times

F. Cleaning and Lubricating After Each Use

G. Cleaning All Blocks and Their Cases Periodically

IV. THEORY OF LIGHT WAVES

A. Definition and Explanation of the Energy Waveform
   1. Wave lengths of visible light
   2. Wave lengths of invisible light

B. Definition and Explanation of the Term Frequency
   1. Frequency of visible light
   2. Frequency of invisible light

C. Define and Explain the Following Terms as Referred to Light
   1. Reflection and refraction

IV. THEORY OF LIGHT WAVES (Contd.)

2. In-phase and out-of-phase in relation to light bands and dark bands
3. Sine wave, fringe bands, and amplitude in reference to light waves

V. EQUIPMENT USED FOR MEASURING WITH LIGHT WAVES

A. The Optical Flat
1. How the optical flat is made
a. Material used
b. Coatings used
2. Shapes of the optical flat
3. Sizes of optical flats
4. How working surface is identified

B. Light Sources Used with Optical Flats
1. Explain monochromatic light
2. Construction and operation of light source fixtures
3. Methods and devices used for counting fringe bands

VI. TECHNIQUES FOR MEASUREMENT WITH LIGHT WAVES

A. Positioning Part and Light Source

B. Proper Selection of Optical Flat

C. Importance of Cleanliness

D. Finding the Reference Point

E. Determining Degree of Surface Flatness

F. Measuring Micro-dimensions Between a Known and an Unknown Part

VII. CARE AND HANDLING OF OPTICAL FLATS AND RELATED EQUIPMENT

A. Cleaning and Storing Optical Flats
   1. Avoiding fingerprints
   2. Using lint free tissues or soft cotton
   3. Use only recommended solvents

B. Cleaning and Minor Maintenance of Light Source Equipment

VIII. QUINMESTER POST TEST

BIBLIOGRAPHY
(Using Gage Blocks as Measuring Standards)

Basic References:

1. Busch, Ted. Fundamentals of Dimensional Metrology. Wilkie Brothers Foundation. Albany, New York: Delmar Publishers, Inc., 1966. The above consists of a text of 426 pages and a lab workbook of 226 pages.

Supplementary References:

2. Juran, J.M. Quality Control Handbook. 2nd edition. New York: McGraw Hill Book Co., Inc., 1951. Pp. 800.

3. Kennedy, Clifford W., and Andrews, Donald E. Inspecting and Gaging. New York: Industrial Press, Inc., 1967. Pp. 590.

Films:

1. Black Granite Gages. 16mm. 19 min. Color. Sound. 1969.

2. How to Calibrate Gage Blocks. 16mm. Color. Sound. 1969.

3. Profile in Precision. 16mm. 20 min. Color. Sound. 1969. Brown and Sharpe Manufacturing Company.

4. Tools and Rules for Precision Measuring. 16mm. 38 min. B&W. 1969. L.S. Starrett Co.

A P P E N D I X

Quinmester Post Test Sample

QUINMESTER POST TEST
(Using Gage Blocks as Measuring Standards)

Name_____Date_____Score_____

1. Are gage blocks ever used DIRECTLY for measuring?

2. Gage blocks are generally used for what method of measurement? (Circle correct answer)
   1. Linear method
   2. Displacement method
   3. Concentric method
   4. Interchange method

3. Gage blocks come in four basic size series. What are they?

4. What are WEAR BLOCKS how and why are they used?

5. What is the WRINCING INTERVAL?

6. List at least five points pertaining to good gage block USE and CARE.

7. Determine the minimum number and size gage blocks you would need to give you the following dimensions. Show your work on the back of this page.
   0.2473"
   0.5046"
   3.3456"

8. You wish to check a 0.035" feeler gage. Show by gage block arrangement and size how you would do this. (Work out answer in the space below)

9. Gage blocks provide discrimination in _____ mil (or inch) increments.

10. What is meant by attribute gaging?

11. For the purpose of calibration, measurements do not have to be made at the standard temperature of 68 degrees F. This statement is true or false. (Underline one)

12. What is the most practical standard for calibrating measuring instruments?

13. Why is it more difficult to calibrate internal measuring instruments?

14. Name a popular light source used with optical flats.

15. Light waves are now used as the international light standard. Name the isotope that emits this light standard.

16. The dark bands we see from the optical flat are the result of: (Circle the correct answer)
    1. in phase
    2. out of phase, light bands

17. Greater separation between optical flat and surface being observed causes MORE OR LESS fringe bands to form. (Circle the correct answer)

18. Explain Monochromatic light.

19. Using the optical flat. Explain how you determine the point of contact or reference line.

20. The height distance from band to band as viewed with the optical flat is always _____.

21. Using the optical flat curvature of the fringe bands indicates what condition of the surface being observed?

22. Can height difference be measured between a known and an unknown part?

ANSWER KEY TO QUINMESTER POST TEST
(Using Gage Blocks as Measuring Standards)

1. Yes.

2. 4, interchange method.

3. .0001", .001", .050", 1.000".

4. .050" and .100" wear blocks are used at ends of gage block stacks to save blocks from damage when blocks are used for direct measurement.

5. The space between the wrung gage blocks.

6. 1. stand on sides
   2. keep box closed
   3. do not leave blocks wrung together
   4. clean thoroughly before wringing
   5. handle as little as possible

7. 0.2473"

2473	
-1003	1003
1470	
1470	1470
0000	.2473"

0.5046"

5046	
1006	1006
4040	
1040	1040
3000	
3000	3000"
0000	.5046

3.3456

3.3456	
1006	1006
3.2450	
.1050	1050
3.1400	
.1400	1400
3.0000	
3.0000	3.0000"
0.0000	3.3456

8. Dimension blocks .235 • 105 ↓ 130
   Anvil block .200
   .035

9. .1 mil or .0001".

10. Use of snap or go-no go gages for culling or sorting into size groups.

11. True.

12. Gage blocks.

13. Most standards have male features.

14. Helium.

15. Krypton 86.

16. 2. Out of phase.

17. More.

18. Light of one color.

19. Pressure at point of contact causes no movement of bands. Pressure at opposite side causes a spread of bands.

20. 11.6 mike (microinches)

21. Curved surface, either convex or concave.

22. Yes.